

REMARKS

By the foregoing Amendment, Claims 1, 14, 23 and 36 are amended. Entry of the Amendment, and favorable consideration thereof, is earnestly requested. Applicant believes that entry of these Amendments is proper as they place the application in condition for allowance and merely clarify claim limitations already present, thereby not requiring further search or consideration.

The present invention is directed to a system for controlling application of an electronically controlled brake which obviates many of the problems associated with prior art brake control systems which rely on undesirable types of sensor feedback in determining when to, and to what extent to, cause application of the brake actuator. To this end, all claims require, among other elements, (i) a position sensor which produces a current position signal indicative of a current position a moveable brake component, (ii) a position indicative command indicative of a commanded position to which the at least one moveable brake component is to be moved in order to achieve a demanded level of braking, and (iii) a brake controller which causes application of a brake actuator based at least in part upon a comparison of the position indicative command with the current position signal.

Applicant respectfully submits that none of the prior art cited by the Examiner, either alone or in combination, discloses, teaches or suggests such an arrangement.

With respect to Ichinose et al., Applicant acknowledges that this reference does appear to teach the determination of a location of a brake system component and then setting of a pad clearance of the brake based in part upon this sensed location:

... The braking force is determined by the pressure exerted by the brake pads 2. The braking force, therefore, can be measured by a force sensor or can be determined from the torque of the motor constituting the actuator 1, i.e. the magnitude of the current flowing in the motor.

The position of the brake pads 2, on the other hand, can be determined by counting the number of revolutions of the motor for driving the actuator 1.

According to this embodiment, therefore, a counter 87 for detecting the revolution speed of the motor and a current detector 88 for detecting the current flowing in the motor are used as a means for detecting the relative position of the pads.

(Column 3, lines 27-40).

This information is used to attempt to maintain a pad clearance, which process essentially works as follows. First, a mechanic sets the desired pad clearance during installation or maintenance. Then, the brakes are applied and the counter 87 counts the number of motor revolutions before the pad contacts the disc (as sensed by current detector 88 when the motor current increases). The number of revolutions between the set pad clearance and the time when the pad contacts the disc is stored in a pad clearance memory 202. Later, whenever the brakes are released, the motor is caused to revolve in reverse the number of revolutions stored in the pad clearance memory 202, which should theoretically cause the pad to return to the desired pad clearance. (See Column 3, line 50 - Column 4, line 21).

Thus, position is employed in that once the brakes are released, the motor is engaged for a pre-determined number of revolutions based upon the stored value in the pad clearance memory 202. However, no positional feedback (i.e., current position signal) is provided, as is required by the claims. The system disclosed in Ichinose et al. attempts to engage the motor for a predetermined number of revolutions and then assumes that the motor has moved the desired

number of revolutions. There is no comparison of a position indicative command with a current position signal (i.e., there is no positional feedback) as is required by all claims of the present application. In fact, Ichinose et al. explicitly states that there is no position sensor whatsoever in the system thereof, while a position sensor is required by all claims. More specifically, Ichinose et al. explicitly states at Column 4, lines 33-45, that:

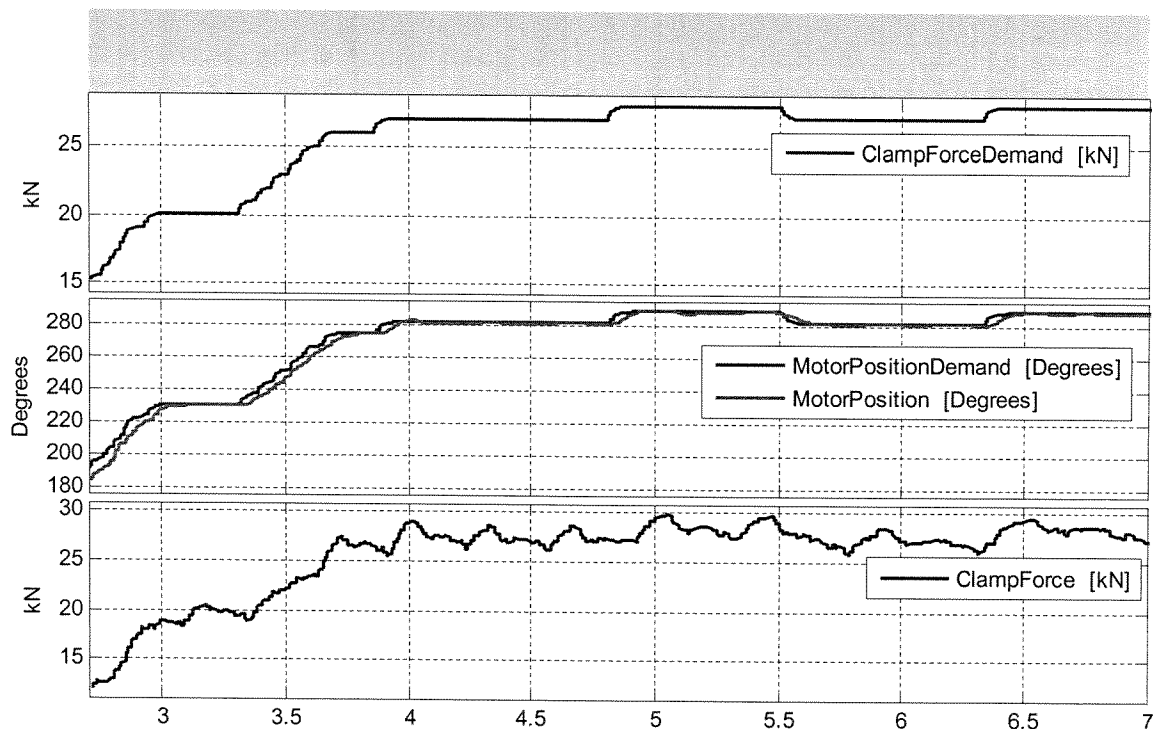
Further, when terminating the braking force control upon discontinuation of the braking force demand input, as at step 33 in FIG. 3, the pad clearance is set again as in the initialization. Specifically, a command is issued from the pad position control unit 103 to reverse the motor operation by an amount corresponding to the pad clearance set by the pad clearance memory 102 in FIG. 1 thereby to separate the brake pads 2 from the brake disk 3. The revolution speed for this driving operation is equal to that of the reverse rotation for initialization, and therefore without a sensor or the like for measuring the position of the brake pads, the position at which the brake pads 2 contact the brake disk 3 can be determined.

(emphasis added).

Instead, like much of the prior art previously cited during prosecution, and like much of the prior art discussed in the background portion of the present application, Ichinose et al. relies upon brake force sensors (in the form of a motor current detector 88 in some embodiments and in the form of a flow rate detector 47 or pressure sensor 46 in other embodiments) for controlling application of the brake actuator. Ichinose et al. employs position only indirectly (and not in the claimed manner) and only to set pad clearance, but not to control application of the brake actuator.

Thus, the system disclosed in Ichinose et al. suffers from a number of disadvantages. One of such disadvantages is that control of brake application based upon sensed and commanded brake force leads to numerous problems, as discussed in the background section of the present application. To more clearly

illustrate some of these disadvantages, Applicant below includes illustrations which graphically demonstrate the relationship between the demand for clamping force (ClampForceDemand), the commanded position of the moveable brake component (MotorPositionDemand), the actual sensed position of the moveable brake component (MotorPosition) and the actual clamping force (ClampForce):



The primary command to the brake is, in this case, the ClampForceDemand, in this case originating from the brake pedal. These primary demands are then converted to a corresponding position demand signal, in this case a MotorPositionDemand signal. This conversion is done by using the known physics of disc braking, i.e, by using the known elasticity in the brake actuator transmission, as more fully described in the present application. Now the actual control takes place. By using feedback of the actual sensed position signal, in this case the sensed MotorPosition signal, the MotorPosition is controlled to follow the

MotorPositionDemand signal. The result of the control is that the actual ClampForce, is approximately following the commanded ClampForceDemand. In the illustrations it can be seen that the quality of the sensed ClampForce signal is worse than quality of the MotorPosition signal, which is typical for these kinds of systems.

Applicant respectfully submits that there is a clear difference between the control scheme of the present invention and control schemes previously known in disc brake actuators. If known control schemes, such as those described in Ichinose et al., use any feedback at all, they are using sensed feedback of, for example, the clamping force (e.g., ClampForce) or the brake torque. Since the quality and the resolution of the position signal (MotorPosition) indicative of the sensed position of the moveable brake component typically is much better than for systems based on sensed feedback of for example the clamping force (e.g., ClampForce) or the brake torque, this leads to considerably improved performance of the brake actuator based on the position control scheme compared to other known control schemes.

Another disadvantage of systems of the type disclosed in Ichinose et al. is that the “assumption” that the motor has moved the desired number of revolutions may not be correct. This may occur for a number of reasons, such as wear of system components, dimensional changes caused by heat, the presence of foreign objects (e.g., dirt, debris, moisture, etc.) within the system, and many others. Thus, not only would the system disclosed in Ichinose et al. be unreliable during brake application (since application is controlled based upon sensed and commanded brake force), but it would also be unreliable during the maintenance of pad clearance (since the maintenance of pad clearance is based upon assumptions that the pad reaches certain positions, rather than upon actual position sensed by a position sensor).

None of these problems are encountered when control of brake application is based on a comparison of a position indicative command with a current position signal sensed by a position sensor, as is required by all claims.

In the Final Office Action dated September 7, 2006, the Examiner states a belief that the position where the brake pads 2 come in contact with the brake disc 3, which position is known to the control unit, is somehow equivalent to the claimed position indicative command indicative of a commanded position of the brake component. Applicant respectfully disagrees. The “contact position” in Ichinose et al. is merely a *known* position which is used to determine when to slow brake pad advance so as to soften initial contact between the pads 2 and the disc 3. This “contact position” is not a *commanded* position (i.e., a position to which at least one moveable brake component is to be moved in order to achieve a demanded level of braking). It should be noted that all independent claims have been amended to clarify this distinction by more clearly defining what is meant by “commanded position.”

As discussed above, Ichinose et al. clearly and explicitly relies upon brake force sensors (in the form of a motor current detector 88 in some embodiments and in the form of a flow rate detector 47 or pressure sensor 46 in other embodiments) for controlling application of the brake actuator. In Ichinose et al., no position indicative command indicative of a commanded position of the brake component (i.e., a position to which at least one moveable brake component is to be moved in order to achieve a demanded level of braking) is ever determined or compared with a current position of the brake component.

With respect to Karnopp et al., Applicant respectfully submits that this reference teaches nothing that would cause one skilled in the art to modify

Ichinose et al. to arrive at the present invention, and indeed, Karnopp et al. is cited merely as teaching a self-energizing brake actuator.

For the foregoing reasons, Applicant respectfully submits that all pending claims, namely Claims 1-45, are patentable over the references of record, and earnestly solicits allowance of the same.

Respectfully submitted,



Wesley W. Whitmyer, Jr., Reg. No. 33,558
Todd M. Oberdick, Reg. No. 44,268
ST. ONGE STEWARD JOHNSTON & REENS LLC
986 Bedford Street
Stamford, Connecticut 06905-5619
(203) 324-6155
Attorneys for Applicant